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(54) Title: BALE WRAPPER APPARATUS

(57) Abstract

A bale wrapper apparatus for applying stretchable plastics film wrapping (in two or more stages) around a bale (14) which has: an axis of symmetry (15), a pair of opposed planar end faces (16) extending substantially perpendicular to the axis (15), and an outer surface (17, 18, 19, 20) extending between the planar end faces (16), and in which the apparatus comprises: a platform (30) for supporting the bale (14) with its axis (15) extending horizontally; a first travelling film reel support (21) movable in a horizontal plane along an orbital path (22) above the platform (30) and which applies one or more windings of the film around the bale (14) so as to cover the planar end faces (16) with one or more layers, and also to extending along the opposed sides (19, 20) of the outer surface of the bale between the planar end faces (16); a second travelling film reel support (24) which is movable in a vertical plane and along an orbital path around the axis (15) of the bale (14a) to apply windings of film around the outer surface (17 to 20) of the bale (14a); and means to cause relative longitudinal displacement between the bale (14a) and the second reel support (24) whereby helical overlapping windings of film can be applied to the bale to cover the outer surface (17 to 20) of the bale as a final wrapping stage.

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BALE WRAPPER APPARATUS

This invention relates to a bale wrapper apparatus for applying stretchable plastics film wrapping around a bale.

The concept of wrapping bales with pre-stretched plastics film is now well established, and especially in relation to the wrapping of bales of agricultural crops, such as hay, straw and grass. In the case of a dried crop e.g. hay or straw, the wrapping serves as weatherproofing i.e. to exclude rain from coming into contact with the baled material which would cause spoilage of the crop; and in the case of a crop still containing a high proportion of water i.e. a low dry matter content, such as newly mown grass which is then baled, the wrapping serves to exclude both rain and atmospheric oxygen and thereby allows fermentation of the crop over a relatively short period of time e.g. two to three weeks, to form silage.

Agricultural bales are usually formed as "cuboids" (a rectangular parallelepiped) having a rectangular cross-section or in cylindrical form known as "big bales" or "round bales", and most current designs of bale wrapper apparatus are designed specifically to handle and apply film wrapping to cylindrical bales.

One known type of bale wrapper apparatus comprises a rotating platform type of bale wrapper e.g. as disclosed in GB Patent No 2159489, and which comprises a turntable carrying a laterally spaced pair of horizontal rollers on which the cylindrical bale is loaded with its axis extending horizontally, and which rotate the bale about its axis while simultaneously the turntable is rotated about a substantially vertical axis. A fixed support stand is mounted on the apparatus and carries a dispenser reel of stretchable plastics film, and following attachment of the leading end of the film to the bale, (manually or automatically by a film applicator unit as disclosed e.g. in more detail in EP 0367529 Kverneland Underhaug AS), the combined effect of the two rotations applied to the cylindrical bale result in

withdrawal of film from the reel and which forms helically overlapping windings around the bale.

A further known type of bale wrapper apparatus is an orbiting "satellite" type of bale wrapper apparatus e.g. as disclosed in EP 0234763 (Oiestad), and in which the table on which the bale is loaded is non-rotatable, and a support carrying the film dispenser reel is caused to orbit around the bale while the bale is rotated about its axis. This achieves the same result as with the first type of apparatus, and has the advantage of avoiding the necessity to rotate the table and the bale on it about the vertical axis, which generates substantial rotational inertia.

Both of these known types of bale wrapper apparatus are designed to receive a cylindrical bale with its axis extending substantially horizontally when the apparatus is on level ground, and with this axis extending parallel to the axes of the support rollers on which it is placed, and which apply the necessary rotation to the bale about its axis.

However, despite the widespread use of cylindrical bales, which have to a large extent superseded the previous use of rectangular section bales in the last ten years or so, there is still a considerable and growing interest in rectangular section bales.

In particular, there are two advantages of rectangular bales, a first of which is that they can be stacked together for transport and storage in a lesser overall volume than required by equivalent cylindrical bales, since there will be substantially no voids between adjacent rectangular bales, whereas inevitably cylindrical bales placed adjacent to each other will define substantial air spaces between them. Secondly, it is considered that it will be easier to design balers which can compress crop into rectangular bales more densely than into cylindrical form. Thus, crop which is formed into rectangular bales can be compressed by a ram in a compression chamber, and subject to suitably robust design of the chamber and the ram, increase of compression force of the ram will generally fairly easily generate a more densely

packed bale. By contrast, by virtue of the way in which cylindrical bales are formed, it will be a much more difficult task to increase significantly the density of crop in cylindrical bales.

There will be two advantages to the formation of more dense rectangular bales. First of all, transport and storage costs per unit weight of baled material will be reduced, since a given weight of crop can be formed into a lesser number of bales. Secondly, if it is desired to form silage from a wrapped bale, more densely packed crop will be likely to form a better quality of silage, since inevitably there will be less atmospheric oxygen trapped within a densely packed wrapped bale than in a less densely packed bale.

Therefore, especially in the context of silage formation in wrapped bales, manufacturers are increasingly turning their attention to ways of applying pre-stretched film wrapping to rectangular section bales.

Evidently, a cylindrical bale can be readily caused to rotate about its axis at a uniform rate by the support rollers (and any slack belts usually taken over the rollers to form a cradle in which the bale is located), whereas after loading of a rectangular bale on the rollers and belt cradle it is only possible to cause the bale to rotate about its axis in a non-uniform manner. Thus, the bale will tend to carry out a tumbling type of rotation, with the bale carrying out a combined form of rotation, part caused by overall rotation applied to the bale and part caused by the bale rocking intermittently about each of its longitudinal edges from time to time. Therefore, in practice, the longitudinal axis of the rectangular bale will not remain fixed, as in the case of a cylindrical bale, but will tend to carry out an orbital path of movement as the bale is caused to carry out each complete revolution. In addition, the instantaneous angular speed of rotation of the rectangular bale will vary during each revolution.

These two factors make it difficult to carry out reliable and economical usage of pre-stretched film wrapping

of rectangular bales, since good practice requires that a substantial overlap e.g. about 50% should take place between successive windings, and if there is uncertainty over the rotational behaviour of the rectangular bale, it may be necessary to increase the theoretical 50% overlap required so that, in the worst case situation in practice, there will still be a sufficient overlap to provide adequate sealing between successive windings to avoid water / air leakage into the bale. This will inevitably result in increased usage of film.

Many attempts have been made to modify the now well proven design of bale wrappers for cylindrical bales, in order to handle rectangular bales, and including providing rotational control means which engage the tumbling bale and attempt to make the instantaneous speed of rotation more uniform.

These attempts have met with some success, but it is recognised that it will be difficult to provide an arrangement which is as efficient in usage of film, and as predictable in operation, as in the wrapping of cylindrical bales.

The present invention therefore solves the problem of satisfactory wrapping of rectangular section bales by a different approach, and in a way which avoids the necessity to rotate the bale continuously about its longitudinal axis, and therefore provides a more predictable wrapping technique, and more efficient usage of film material.

According to the invention there is provided a bale wrapper apparatus for applying stretchable plastics film wrapping around a bale having an axis of symmetry, a pair of opposed planar end faces extending substantially perpendicular to the longitudinal axis, and an outer surface extending between the planar end faces, and said apparatus comprising:

a platform for supporting the bale with its axis extending generally horizontally when the apparatus is supported over level ground;

a first travelling film reel support which is movable in a substantially horizontal plane along an orbital path above the platform so as to be capable of allowing film to be withdrawn from a supply reel, when carried by the support, and to form one or more windings of film around the bale so as to cover the planar end faces with one or more layers, and also to extend along the opposed sides of the outer surface of the bale between the planar end faces;

a second travelling film reel support which is movable in a plane which is substantially vertical when the apparatus is supported over level ground, and along an orbital path around the axis of the bale, so as to be capable of allowing film to be withdrawn from a supply reel, when carried by the second reel support, and to apply windings of film around said outer surface of the bale; and,

means for causing relative longitudinal displacement between the bale and the second travelling support whereby overlapping windings of film can be applied to the bale so as to cover the outer surface of the bale.

The invention therefore provides a bale wrapper apparatus which has two wrapping modes of operation, in one of which the planar end faces and part of the outer surface of the bale are covered with film wrapping, and in the other of which the outer surface only is covered with film wrapping.

It should be understood that the order in which these two separate wrapping modes take place is not critical, provided that one mode follows the other in order to complete the wrapping of the bale.

The invention is particularly applicable to the wrapping of bales of rectangular parallelepiped form i.e. of rectangular cross section, in which the bale will usually be long relative to its height and width, and will have vertical end faces, and flat horizontal top and bottom surfaces and flat vertical side faces. The vertical end faces will form the "opposed planar end faces" in the definition of the bale to be wrapped by the apparatus of the invention, and the four

top and bottom surfaces and side faces will form the "outer surface" of the bale intermediate the planar end faces.

However, it should be understood that the apparatus according to the invention is not restricted solely in its use to the wrapping of rectangular section bales, and will be capable of wrapping the bales of other shapes, and including shapes which fall within the general definition above.

The platform may take any suitable form, and may, for example, comprise a series of transversely extending rollers onto which the bale can be loaded by relative longitudinal displacement between the bale and the platform.

In one preferred arrangement, there is a forward loader device having a forwardly projecting guide surface which is engageable with the underside of a bale lying on the ground, as the apparatus is moved forwardly towards the bale, and which guides the bale rearwardly onto the platform. However, many other types of guide arrangement, or loader device may be used in order to load the bale onto the platform.

Preferably, the first travelling support is guided to move along an endless path which surrounds at least part of the platform on which the bale is to be loaded and, depending upon the height of the bale and the width of film used, it may be necessary for more than one circuit of the support to take place so that more than one winding is applied around the bale, and with an automatic increase (during or at the end of each revolution) of the height of the reel carried by the support to provide an overlapping winding.

The second travelling support is preferably provided on a separate unit which follows the platform and the first travelling unit (when the bale wrapping process comprises first carrying out horizontal plane wrapping followed by vertical plane wrapping).

The separate unit is arranged to receive the partly wrapped bale from the platform, and then the second travelling support is operated, in conjunction with the relative displacement means, so that the partly wrapped bale has the remaining uncovered surfaces progressively covered.

The second travelling support may orbit in a fixed substantially vertical plane, and the partly wrapped bale may be caused to move longitudinally while the windings are applied around the bale, so that overlapping helical windings are wrapped around the outer surface of the bale, and when wrapping is completed, the wrapped bale can then be discharged rearwardly from this separate unit.

However, it is not essential to the invention to have a final trailed unit provided with the second travelling support. As an alternative, the second travelling support may be mounted on the platform so as to carry out its required path of movement, and this may take place before, or after the wrapping operation carried out by the first travelling support.

Desirably, each travelling support is capable of carrying its own supply reel of stretchable film. However, it is within the scope of this invention for a single piece of equipment to be capable of carrying out both functions of the first and second travelling support. Thus, for example, an adjustable support may be adapted to carry a supply reel, and may be arranged to be adjusted between one mode of operation in which it carries out orbital movement in a substantially horizontal plane for the initial wrapping of the bale, and a second mode of operation in which it carries out orbital movement in a substantially vertical plane to complete the wrapping of the bale.

In this specification, reference to "orbital" movement is intended merely to refer to movement in a closed or endless path or circuit, and which will include circular, elliptical or other shaped closed paths, the particular shape of which may be determined by the particular type of device used to control and guide the movements of the film reels.

By way of example only, the first travelling support may be driven by chains or the like along a fixed guide track provided on the platform, and the second travelling support may be rotated in a circular path around the bale in somewhat similar manner to the existing designs of film applicators

known per se for use in the continuous wrapping of a horizontal stack of bales laid end to end.

In a particularly preferred arrangement, the apparatus comprises three separate units trailed one behind the other, a first of which comprises a loader unit for picking-up a bale lying on the ground, a second of which comprises the platform and first travelling support to partly wrap the bale, and the third of which comprises a final unit provided with the second travelling unit to carry out final wrapping of the bale prior to rearward discharge of the wrapped bale to the ground or a collecting device.

The train of units may be trailed behind a propelling vehicle e.g. an agricultural tractor, and preferably in laterally off-set manner, so that a line of bales previously deposited in the field by a baler can be picked-up, wrapped and discharged on a continuous or semi-continuous basis, subject to appropriate setting of the times of operation for each unit. By way of example only, the picking-up and initial receipt by the loader unit may take 8 seconds, subsequent transfer onto the platform of the second stage, and the carrying out of the first wrapping stage may take about 10 seconds, and finally transfer of the partly wrapped bale to the final unit, completion of the wrapping process, and discharge may take about 25 seconds. Depending on the ground speed of the train of units, and the spacing apart of bales in the field, and the time taken for each handling of the bales, it may be possible for the required operations to take place on a line of bales without the train of units having to stop between bales.

Preferred embodiments of bale wrapper apparatus according to the invention will now be described in detail, by way of example only, with reference to the accompanying schematic drawings, in which:

Figure 1 is a schematic plan view of a first embodiment of bale wrapper apparatus according to the invention and which is operative to apply two stage film wrapping;

Figure 2 is a schematic illustration of the principles

underlying the operations of a second embodiment of the invention, having an additional, intermediate wrapping stage to the first embodiment, to provide three stage film wrapping;

Figure 3 is a schematic illustration, to a larger scale, showing the successive film wrapping stages applied to the six sides of a bale of rectangular parallelepiped form by a second embodiment of apparatus according to the invention;

Figures 4a and 4b show in more detail a support and transfer arrangement for moving the bale between the first wrapping stage and the intermediate wrapping stage in the second embodiment;

Figure 5 is a schematic plan view of one preferred arrangement of film wrapping applicator for use in the second embodiment of the invention;

Figure 6 is a plan view of a detailed example of combined bale lifter device and support platform for the bale while first and second stages of bale wrapping take place;

Figure 7 is a rear view of the bale lifter device shown in Figure 6, and preparatory to engaging a bale lying on a ground to lift it to a wrapping position;

Figure 8 is a view, similar to Figure 7, showing the initial stage of bale lifting;

Figure 9 is a similar view, but showing the bale lifted to the bale wrapping position and supported by a support platform formed by adjustment of the bale lifter device; and

Figure 10 is a schematic side view of a final wrapping stage, arranged downstream of the first and second wrapping stages shown in Figures 6 to 9, to apply orbital film wrapping around the axis of the already wrapped bale, as shown diagrammatically in the final wrapping stage of Figure 1, and as shown schematically in Figure 2e and Figure 3 (III).

Referring now to Figure 1 of the drawings, this is a schematic plan view of a train of three separate units which can be towed behind an agricultural tractor or other propelling vehicle, in laterally off-set manner, in order to

pick-up bales lying on the ground by means of a loader unit, subsequently transferring the picked-up bales to a second unit in which partial wrapping of the bale takes place with pre-stretched plastics film, and subsequent rearward transfer to a final unit which completes the wrapping process and then discharges the wrapped bale rearwardly onto the ground, or to a collecting device.

The drawing is a schematic illustration only, but the components employed to carry out the invention may include standard components currently known for use in the wrapping of agricultural bales with pre-stretched plastics film, and therefore do not need to be described in detail herein.

The bale wrapper apparatus illustrated schematically in the drawings is intended to be towed behind tractor 10 in laterally off-set manner during operation, although the train of trailed units can be displaced to a position directly behind the tractor 10 for transport purposes. The bale wrapper apparatus comprises a train of three units 11, 12 and 13, and which serve to pick-up a bale lying on the ground, and to apply stretchable plastics film wrapping around the bale in a two stage process to form a fully wrapped bale, and which can then be discharged rearwardly.

The type of bale to which the bale wrapper apparatus of the invention is particularly suited for handling is a rectangular cross section bale 14 having a longitudinal axis of symmetry 15, a pair of opposed planar end faces 16 extending substantially perpendicular to longitudinal axis 15, and an outer surface extending between the planar end faces 16 and formed by horizontal top and bottom flat surfaces 17 and 18, and opposed side faces 19 and 20.

The two stage wrapping components of the apparatus has a first stage comprising a substantially horizontal platform 30 provided in unit 12, and which serves to support the bale 14 with its longitudinal axis 15 extending substantially horizontally when the apparatus is supported over level ground. A first travelling film reel support 21 is movable in a substantially horizontal plane along an orbital path 22

above the platform 30 so as to be capable of allowing film to be withdrawn from a supply reel 23, when carried by travelling support 21, and which can form one or more windings of film around the bale 14 so as to cover the planar end faces 16, and also to extend along the opposed sides 19 and 20 of the outer surface of the bale and thereby form a partly wrapped bale.

The travelling film reel support 21 may comprise a dispenser unit of the type known for use in "satellite" types of bale wrapper apparatus, such as that disclosed in EP 0234763 (Oiestad). Any suitable guide / support arrangement may be provided in order to cause the travelling support 21 to orbit along the required closed path 22. The leading end of the film carried by reel 23 can be attached at a suitable starting point to the outer periphery of the bale 14, either manually or by any automatically operating film applicator, and then orbiting movement around path 22 will result in application of pre-stretched film windings around the bale 14, and this will take place until the end faces 16 are fully covered. Desirably, the width of the film used is approximately equal to the height of the bale 14, so that one revolution of the dispenser unit will result in complete coverage of the end faces, although it should be understood that this is not essential to the invention. Thus, if the film width is less than the height of the bale, it will only be necessary to ensure that the height of the film dispenser reel is adjusted, either stepwise or continuously, respectively during or at the end of each revolution, so that overlapping windings can be applied until such time as the end faces 16 are fully covered throughout their height.

After completion of this partial wrapping in unit 12, the partly wrapped bale can then be discharged rearwardly to a second wrapping stage provided at second wrapping unit 13. A second travelling film reel support 24 is provided at this final unit, and which is movable in a plane which is substantially vertical when the apparatus is supported over level ground, and along an orbital path around the

longitudinal axis 15 of partly wrapped bale 14a, so as to be capable of allowing film to be withdrawn from a supply reel (not shown) when carried by second travelling support 24, and which allows film to be withdrawn from the supply reel to apply windings of film around the outer surface of the bale 14a i.e. the top and bottom faces 17 and 18 and opposed side faces 19 and 20.

Means (not shown) is provided to cause relative longitudinal displacement between the partly wrapped bale 14a and the travelling support 24 whereby helically overlapping windings of film can be applied to the partly wrapped bale 14a so as to cover the entire outer surface of the bale i.e. the surface between the planar end faces 16.

The orbital path of the second travelling support 24 is most conveniently a circular orbit around the longitudinal axis 15, and the arrangement of travelling support 24 and a film dispenser reel (or reels) carried thereby may be of known type used in existing arrangements for applying helical windings of stretched film around a line of bales to form a continuous length or "sausage".

In order to load bales lying on the ground into the apparatus, a forward loader device is provided at first stage 11 of the train of units, and which is designated generally by reference 25. Forward loader device 25 may have a forwardly projecting guide surface (not shown) which is engageable with the underside of a bale lying on the ground, as the apparatus is moved forwardly towards the bale, and which guides the bale rearwardly onto a set of transversely extending transfer rollers 26. However, any suitable type of forward guide arrangement may be provided, to allow slidable loading of the bale rearwardly, or alternatively a forwardly mounted bale pick-up device may be provided, operative to engage a bale lying on the ground and pick it up and transfer it in any suitable way onto the transfer rollers 26.

After picking-up of the bale and application onto the rollers 26, the bale can then be transferred rearwardly to the first wrapping unit 12, and onwardly to the second

wrapping unit 13, as described above. When the first stage of the wrapping has been concluded on unit 12, it may be desirable to move the partly wrapped bale rearwardly while film remains attached to the supply reel 23 and which will be withdrawn from the reel as the bale moves through the centre of the orbital path of travelling support 24, whereby the trailing end portions of film can be progressively wrapped by the second wrapping phase. The film will be cut from the reel 23, preferably automatically, at a convenient time.

The schematically illustrated embodiment of bale wrapper apparatus is particularly suitable for handling rectangular cross section bales, although it should be understood that the invention will be applicable generally to the two stage wrapping of bales having a longitudinal axis, opposed planar end faces extending substantially perpendicular to the longitudinal axis, and an outer surface defined between the planar end faces, and in which one of the wrapping modes comprises application of film windings to cover the planar end faces at least, and the other wrapping mode of which comprises application via helically overlapping windings around the remaining outer surface i.e. all external surfaces of the bale except the planar end faces.

Furthermore, while the described embodiment provides, consecutively, initial wrapping to form a partly wrapped bale by travelling support 21 which orbits in a substantially horizontal plane, followed by completion of the wrapping via orbital movement of the film dispenser unit in a substantially vertical plane, these two processes could be reversed in order.

Further, in the schematically illustrated embodiment, the second travelling support 24 is provided on a separate unit 13 which follows the platform 30 of the first travelling unit 12, so that the two stage bale wrapping process comprises a first stage of orbital movement of a film dispenser unit in a substantially horizontal plane, followed by orbital movement of a film dispenser unit in a substantially vertical plane. However, it is not essential

to the invention to have a final trailed unit provided with the second travelling support 24. By way of example, the second travelling support 24 may be mounted on platform 30 of the unit 12 so as to carry out its required path of movement, and preferably this will take place after the first operation carried out by the first travelling support 21. However, the arrangement also could be that the first wrapping process is applied by second travelling support 24, followed by completion of the wrapping process by the first travelling support 21.

In the schematically illustrated arrangement, each of the travelling supports 21 and 24 will be capable of carrying its own supply reel of stretchable film. However, as a further variation within the scope of the invention, a single piece of equipment may be provided which is capable of carrying out both functions of the first and second travelling supports 21, 24. For example, this piece of equipment may include an adjustable support which is adapted to carry a supply reel, and which can be adjusted between one mode of operation in which it carries out orbital movement in a substantially horizontal plane equivalent to the operation of first travelling support 21, and a second mode of operation in which it carries out orbital movement in a substantially vertical plane similar to second travelling support 24.

In the schematically illustrated arrangement, the orbital movement of first travelling support 21 is along a substantially elliptical path 22, whereas the orbital movement of second travelling support 24 is circular. However, neither of these paths are essential to the invention, and any suitable closed or endless path or circuit may be followed, provided that it surrounds the bale to be wrapped, and the particular shape which is adopted may be determined by the particular type of device used to control and guide the movements of the film reels.

The first travelling support 21 may be carried by an overhead arm which rotates about a substantially vertical

axis, and which causes travelling support 21 to carry out a required orbital path of movement. Alternatively, travelling support 21 may be caused to follow a fixed guide track provided on the platform, along which it is driven by chains or the like.

The three units 11, 12 and 13 comprise a train of units trailed behind tractor 10, and in laterally off-set manner during operation, so that a line of bales previously deposited in the field by a baler can be picked-up, wrapped and discharged on a continuous or semi-continuous basis, subject to appropriate setting of the times of operation of each unit. By way of example, the bale pick-up unit 11 may have an operating time of about 8 seconds, (to pick-up then rearwardly transfer the picked-up bale onto the platform of second unit 12); the unit 12 may have a partial wrapping cycle and rearward discharge lasting about 8 seconds, and the third unit 13 may have a final wrapping and rearward discharge cycle of about 25 seconds. Time taken in unit 13 is longer, because a greater area of film wrapping will be applied around the partly wrapped bale 14a, in view of its substantial length relative to its height and width.

There has been described above with reference to Figure 1 a first embodiment of bale wrapper apparatus according to the invention, which provides two stage film wrapping around a bale. There will now be described a further preferred development of the invention, in which an additional intermediate wrapping stage is provided.

Figure 2 illustrates schematically the principles underlying the operation of this further embodiment, in which the first stage I is shown under illustration a, a transfer step is shown by illustration b, a second stage II of wrapping is shown by illustration c, and a partly wrapped bale having undergone stages I and II is shown by illustration d. As can be seen from illustrations a to d, the partly wrapped bale thus formed has four layers of film wrapping applied to each of the opposed vertical end faces of the bale, and two layers of film wrapping applied to each of

the four remaining sides of the bale.

Illustration e shows schematically the final (third) stage of film wrapping, and illustration f shows the final result, in which four layers of film winding are applied to each of the six sides of the cuboid form bale.

Referring now to Figure 3, this shows schematically, and to a larger scale, the application of film windings to a six-sided bale (40) of cuboid or rectangular parallelepiped form, having opposed first, second and third pairs of sides a1-a2, b1-b2 and c1-c2.

In the first stage, the travelling film reel support 21 is caused to orbit in a horizontal plane around the bale 40, so as to apply two layers of film winding along, successively, sides b1, c1, b2, c2. Desirably, the height of the film reel is approximately equal to the height of the sides b1, b2, c1, c2, or possibly slightly greater. Thereafter, the partly covered bale 40 is caused to rotate about its axis 15 through approximately 90°, so that the previously bottom side a1 on which it was supported moves to an upright position, as can be seen from the two section illustrations at the right hand side of Figure 3.

The film reel support 21 is then caused to orbit in a horizontal plane so as to apply two layers of film winding to, successively, the sides b1, a2, b2, a1. If the height of the film reel is less than the height of the sides a1 and a2, the travelling film reel support 21 may be caused to move upwardly or downwardly, either stepwise or continuously, so that complete coverage of the sides b1, b2, a1, a2 takes place with two complete overlapping layers of film.

The partly wrapped bale 40a now has four layers of film on each of the vertical end faces b1 and b2, and two layers on each of the remaining four sides a1, a2, c1, c2, as shown schematically in Figure 2d.

The second travelling film reel support 24 is then caused to orbit in a substantially vertical plane in order to apply two further layers of winding around the sides a1, a2, c1, c2. These windings may be helically overlapping

windings, if continuous relative displacement is caused between the second travelling film reel support 24 and the partly wrapped bale 40a. Alternatively, step-wise relative advance may be provided, at the end of each complete orbit or orbits around the bale, so as to provide overlapping windings which cover sides a1, a2, c1, c2 of the bale with at least two layers of film windings.

Referring now to Figures 4a and 4b, this shows schematically a platform type of support of the bale, comprising two separate flat supports 42 and 43, and Figure 4a shows the adjusted position taken up by supports 42 and 43 in order, as shown in the left hand view, first to apply first stage film wrapping, and then in the right hand view ready to rotate the bale through 90° about its axis to take up a position ready for the intermediate stage of film wrapping, as shown in the left hand view of Figure 4b. Support 42 is then lowered to the position shown in the right hand view on Figure 4b, and the intermediate film wrapping stage then takes place i.e. step 2.

Finally, referring now to Figure 5, this shown one particularly preferred arrangement for a first travelling film reel support, designated by reference 21a, which is carried by a rotating carrier arm 41, and which can be adjusted between first and second operating positions, so that the travelling film reel support 21a can carry out required orbital paths of movement in order to carry out both the first stage of film wrapping in step 1, and the intermediate stage of film wrapping in step 2.

There have been described above with reference to Figures 1 to 5 the support of a bale (which is to be wrapped) on a supporting platform (30), which supports the bale while first and second stages of bale wrapping take place, by orbital movement in a horizontal plane of a first travelling film reel support (21), and which is followed by a final stage of bale wrapping obtained by carrying out orbital movement of a second travelling film reel support (24) which moves in a substantially vertical plane and along an orbital

path around the axis of the partly wrapped bale, with means being provided to cause relative longitudinal displacement between the partly wrapped bale and the second travelling film reel support so that helically overlapping windings of film can be applied to the bale to complete the wrapping of the bale.

The platform is only shown schematically in Figures 1 to 5, and Figures 6 to 9 show one example, in more detail, of a device which can perform dual function of both acting as a bale lifter device, and also to support the bale for wrapping after it has been lifted to a wrapping position. It is also capable of rotating the bale about its axis, after a first stage of bale wrapping has been completed, and through 90°, so that a second stage of bale wrapping can take place, as described above and shown schematically in Figures 2a to 2d, and also in Figures 3 (I) and 3 (II).

Referring now to Figures 6 to 9, there is shown a bale wrapper apparatus designated generally by reference 100 which is being towed in the direction of arrow X in Figure 6 behind a propelling vehicle in the form of tractor 111 in a laterally off-set position so that the tractor 111 can run alongside a line of bales deposited in a field, of which one is shown by dotted outline 112. It can be seen from Figure 6 that the apparatus 100 is readily lined-up with the bale 112, and is able to receive the bale, lift it, apply stretchable plastics film wrapping around it, and then rearwardly discharge the wrapped bale during forward movement of the tractor 111 and apparatus 100 towards the next bale in the row.

The apparatus 100 comprises a frame designated generally by reference 113, coupling means in the form of a towbar 114 attached to and projecting forwardly of the frame 113 to enable the apparatus 100 to be towed behind the tractor 111, and an arch structure 115 which forms part of the frame 113 and which faces in the intended direction of travel and which is of sufficient size to allow bale 112 lying on the ground to pass through the arch 115 when the

apparatus 100 is moved forwardly.

In the illustrated embodiment, arch 115 is located at the rear end of the frame 113, and therefore it will be the wrapped bale which is discharged through the arch 15 after completion of the first two stages of the wrapping operation.

A 2-part bale lifting cradle designated generally by reference 160 is mounted on the frame 113 and is operative to lift the bale 112, after it has been received by the apparatus, to take-up a raised bale-wrapping position. The lifting cradle 160 comprises a pair of lifting roller assemblies which are laterally spaced from each other to allow bale 112 to be received between them, and each assembly is operative to engage at least an adjacent side and / or underside of the bale 112 and to lift the bale to the bale-wrapping position. In the case of a rectangular cross section bale, each lifting assembly engages with the adjacent substantially vertical opposite side of the bale. Each lifting assembly comprises mounting plates 117 pivotally mounted on the end of a support arm 118 and which can be pivoted inwardly and outwardly via the arm 118 between positions of different spacings apart from each other of the two cradle assemblies to allow different widths of bale to be handled. Each pair of plates 117 carries two rollers 119 which extend generally parallel to the direction of travel, and are located one above the other, as shown in Figure 7, prior to being pivoted inwardly into engagement with the adjacent vertical sides 127 of bale 112. Then, upon the application of drive to the rollers 119, the bale can be lifted by frictional contact between the rollers and the sides 127 of the bale.

Figure 8 shows an initial stage in the lifting operation, and Figure 9 shows bale 112 lifted to a wrapping position, and in which arms 118 have been pivoted inwardly, and each cradle support carrying the rollers 119 also pivots so that all four rollers 119 are arranged in the horizontal plane forming a load supporting platform for the bale 112, so that the first stage of bale wrapping can then take place by

orbital movement of travelling film reel support 120 which moves in a circular orbit in a horizontal plane under the action of arm 121 rotating about vertical axis 122 via rotary mounting 123. Rotary mounting 123 is carried on the end of a horizontal support arm (not shown) secured to and projecting from the upper end of arch frame 115.

This first stage of wrapping covers the opposed side faces 127 of bale 112, and also the front and rear end faces. This corresponds with the schematic illustration in Figure 3 (I). The bale 122 can then be rotated through 90° by application of suitable drive to the rollers 119 (if necessary accompanied by further inward movement of the cradle assemblies towards each other), so that the bale then takes-up the position shown in Figure 3 (II). The orbiting film reel support 120 then carries out further wrapping movement to complete the second stage of wrapping and, if necessary because of the increased height of the bale, means may be provided to cause the travelling film reel support also to move vertically while it is carrying out its orbital movement, in order to completely cover the now vertical side faces and end faces of the partly wrapped bale.

The apparatus 100 is towed behind a tractor 111 in laterally off-set manner via towbar 114 which is connected via a simple towing hitch to the rear of a tractor, and ground wheels 125 of the apparatus 100 enable it to follow the tractor in the manner of a trailer.

Figures 1 to 5 show schematically various stages of wrapping of the side and end faces of rectangular cross section bales, and the description of the example shown in Figures 6 to 9 thus far comprises first and second stages of wrapping by horizontal orbital movement of film reel support 120.

The final stage of wrapping of the now partly wrapped bale will now be described with reference to schematic illustration in Figure 10. This corresponds to the final stage of wrapping as shown schematically in Figure 3 (III).

The wrapped bale is shown by reference 112A in Figure

10, supported by the rollers 119, and means is provided (not shown in detail) to push the wrapped bale 112A in the direction of the arrow Y so as to pass through the arch (115), and also through a second travelling film reel support (not shown) and corresponding to film reel support 24 shown in Figure 3 (III), and which conveniently may be incorporated in, or arranged immediately downstream of arch 115. This may comprise a rotating wheel type of arrangement, and as the film reel support carries out orbital movement in a substantially vertical plane around the axis of the bale, film is withdrawn and applied as windings of film around the outer surface of the bale. (The arch 115 and the rotating wheel type film reel support are shown diagrammatically in Figure 10 by combined reference 115A). In conjunction with the rearward movement of the wrapped bale 112A, helically overlapping windings of film are applied to the bale in order to complete the final stage of wrapping.

As the bale 112A passes through the rotating wheel type of film reel support 115A, it is guided to carry out horizontal rearward movement and passes on to horizontal support rollers 126 which allow the bale to move rearwardly as the wrapping operation proceeds, and after it has been completed, the fully wrapped bale can then fall downwardly under gravity onto the ground.

Any suitable known types of automatically operating devices may be provided (not shown) to assist the initial application of the film from the film reel supports during initial stages of wrapping, and after wrapping is completed automatic film cutting and clamping devices may be provided as is known in the general art of bale wrapping.

CLAIMS

1. A bale wrapper apparatus for applying stretchable plastics film wrapping around a bale (14) having an axis of symmetry (15), a pair of opposed planar end faces (16) extending substantially perpendicular to the axis (15), and an outer surface (17, 18, 19, 20) extending between the planar end faces (16), and said apparatus comprising:

a platform (30) for supporting the bale (14) with its axis (15) extending horizontally when the apparatus is supported over level ground;

a first travelling film reel support (21) which is movable in a substantially horizontal plane along an orbital path (22) above the platform (30) so as to be capable of allowing film to be withdrawn from a supply reel (23), when carried by the support (21), and to form one or more windings of film around the bale (14) so as to cover the planar end faces (16) with one or more layers, and also to extend along the opposed sides (19, 20) of the outer surface of the bale between the planar end faces (16);

a second travelling film reel support (24) which is movable in a plane which is substantially vertical when the apparatus is supported over level ground, and along an orbital path around the axis (15) of the bale (14a), so as to be capable of allowing film to be withdrawn from a supply reel, when carried by the second reel support (24), and to apply windings of film around said outer surface (17 to 20) of the bale (14a); and,

means for causing relative longitudinal displacement between the bale (14a) and the second reel support (24) whereby overlapping windings of film can be applied to the bale so as to cover the outer surface (17 to 20) of the bale.

2. Apparatus according to Claim 1, in which the first travelling support (21) is arranged to carry out initial wrapping of the bale (14) to form a partly wrapped bale (14a) having film covering the planar end faces (16) and also extending along the opposed sides (19, 20) of the outer

surface of the bale between the planar end faces, and in which the second travelling film reel support (24) is arranged to apply helically overlapping windings of film to the partly wrapped bale (14a) so as to cover the outer surface (17 to 20) of the bale.

3. Apparatus according to Claim 1 or 2, including a forward loader device (11) operative to receive a bale (14), and to transfer the bale rearwardly to the platform (30) of a first stage wrapping unit (12).

4. Apparatus according to Claim 3, in which the forward loader device (11) has a forwardly projecting guide surface, engageable with the underside of a bale lying on the ground, and transfer rollers (26) located behind the guide surface, the arrangement being such that as the apparatus is moved forwardly towards the bale, the bale can be picked-up and transferred onto the transfer rollers (26).

5. Apparatus according to Claim 3, in which a forwardly mounted pick-up device is mounted on the forward loader device (11), and is operative to pick-up a bale lying on the ground and then transfer it rearwardly onto the loader device (11).

6. Apparatus according to any one of Claims 1 to 5, in which the first travelling support (21) is guided to move along an endless path (22) which surrounds at least part of the platform (30) on which the bale (14) is to be loaded.

7. Apparatus according to Claim 6, including means for adjusting the height of the film dispenser reel (23) carried by the first travelling support (21), either continuously during each revolution, or intermittently at the end of each revolution, so as to provide overlapping windings of films on the bale.

8. Apparatus according to any one of Claims 1 to 7, in which the second travelling support (24) is provided on a separate unit (13) which follows the platform (30) and the first travelling unit (21).

9. Apparatus according to Claim 8, in which displacement means is provided to move the partly wrapped

bale (14a) progressively through the orbital path of movement of the second travelling unit (24) so that overlapping helical windings are applied continuously around the outer surface (17 to 20) of the bale until wrapping is completed, whereby the wrapped bale can then be discharged rearwardly from unit (13).

10. Apparatus according to any one of Claims 1 to 7, in which the second travelling support (24) is mounted on the platform (30) so as to carry out its required orbital path of movement about the longitudinal axis (15) of the bale (14).

11. Apparatus according to Claim 10, in which the second travelling support (24) is operable to carry out final wrapping of the bale by covering the outer surface (17 to 20) after partial wrapping of the bale (14) has been carried out by the first travelling support (21).

12. Apparatus according to any one of Claims 1 to 7, in which a single piece of equipment is provided on the unit (12) and comprises an adjustable support adapted to carry a supply reel, and which can be adjusted between one mode of operation in which it carries out orbital movement (22) in a substantially horizontal plane and thereby provide the function of said first travelling support (21), and a second mode of operation in which it carries out orbital movement in a substantially vertical plane about the axis (15) to provide the function of said second travelling support (24).

13. Apparatus according to any one of Claims 1 to 12, and comprising three separate units (11, 12, 13) trailed one behind the other, the first of which comprises a loader unit (11) for picking-up a bale lying on the ground, a second (12) of which comprises the platform (30) and first travelling support (21) to partly wrap the bale (14), and the third (13) of which comprises a final unit provided with the second travelling unit (24) to carry out final wrapping of the bale prior to rearward discharge of the wrapped bale to the ground or a collecting device.

14. Apparatus according to Claim 13, in which the train of units (11 to 13) is laterally displaceable to an

off-set position behind a propelling vehicle (10), so as to be capable of picking-up consecutively a line of bales deposited in the field, to wrap and then discharge the wrapped bales consecutively.

15. Apparatus according to Claim 1, in which the means for causing relative longitudinal displacement between the partly wrapped bale (14a) and the second reel support (24) is operative to cause continuous relative movement whereby helically overlapping windings of film can be applied to the bale from one end face (15) to the other end face (15) so as to cover the outer surface (17 to 20) of the bale.

16. Apparatus according to Claim 1, in which the means for causing relative longitudinal displacement between the wrapped bale (14a) and the second reel support (24) is operative to apply step-wise relative movement between each application of one or more film winding around the partly wrapped bale (14a) from one end face (15) to the other end face (15) so as to cover the outer surface (17 to 20) of the bale.

17. Apparatus according to any one of Claims 1 to 16, and adapted for use in applying stretchable plastics film wrapping around a six-sided bale (40) of cuboid shape having first, second and third pairs of opposed sides a1-a2, b1-b2, c1-c2, in which the platform is arranged to support one of the first pair of sides a1 of the bale (40), while the first stage of wrapping takes place via the first travelling film reel support (21) to cover the second and third pairs of sides b1-b2, c1-c2 with one or more layers of film winding and thereby form a partly wrapped bale (40a), and in which the apparatus includes means to support the partly wrapped bale (40a) so that a final stage of wrapping takes place via the second travelling film reel support (24) to cover the first and third pairs of sides a1-a2, c1-c2 with one or more layers of film winding.

18. Apparatus according to Claim 17, in which the apparatus is provided with an intermediate wrapping stage for applying film windings to the first and second pairs of sides

a1-a2, b1-b2, said apparatus having means to rotate bale (40) through approximately 90° about its axis (15) and to then support the bale on one of its third pair of sides c1 so that the first and second pair of sides a1-a2, b1-b2 can have layers of film winding applied thereon.

19. Apparatus according to Claim 18, in which the first travelling reel support (21) is operative to carry out the first wrapping stage and the intermediate wrapping stage.

20. Apparatus according to Claim 19, in which the first travelling reel support (21a) is carried at one end of a rotatable arm (41), said arm (41) being adjustable between a first operating position in which the first travelling reel support (21a) can carry out an orbital path of movement to carry out the first wrapping stage, and a second operating position in which the first travelling film reel support can carry out an orbital path of movement to carry out the intermediate wrapping stage.

21. Apparatus according to any one of Claims 1 to 20, in which the platform (30) is formed by a cradle type bale lifter device (160) which is operative to lift a bale (112) lying on the ground and to raise it to a bale wrapping position for a first stage of bale wrapping to be carried out.

22. Apparatus according to Claim 21, in which the lifting cradle assembly (160) comprises a pair of opposed lifting cradles, with each cradle having a pair of rollers (119) engageable with the sides of the bale (127) on the ground to lift it to the wrapping position.

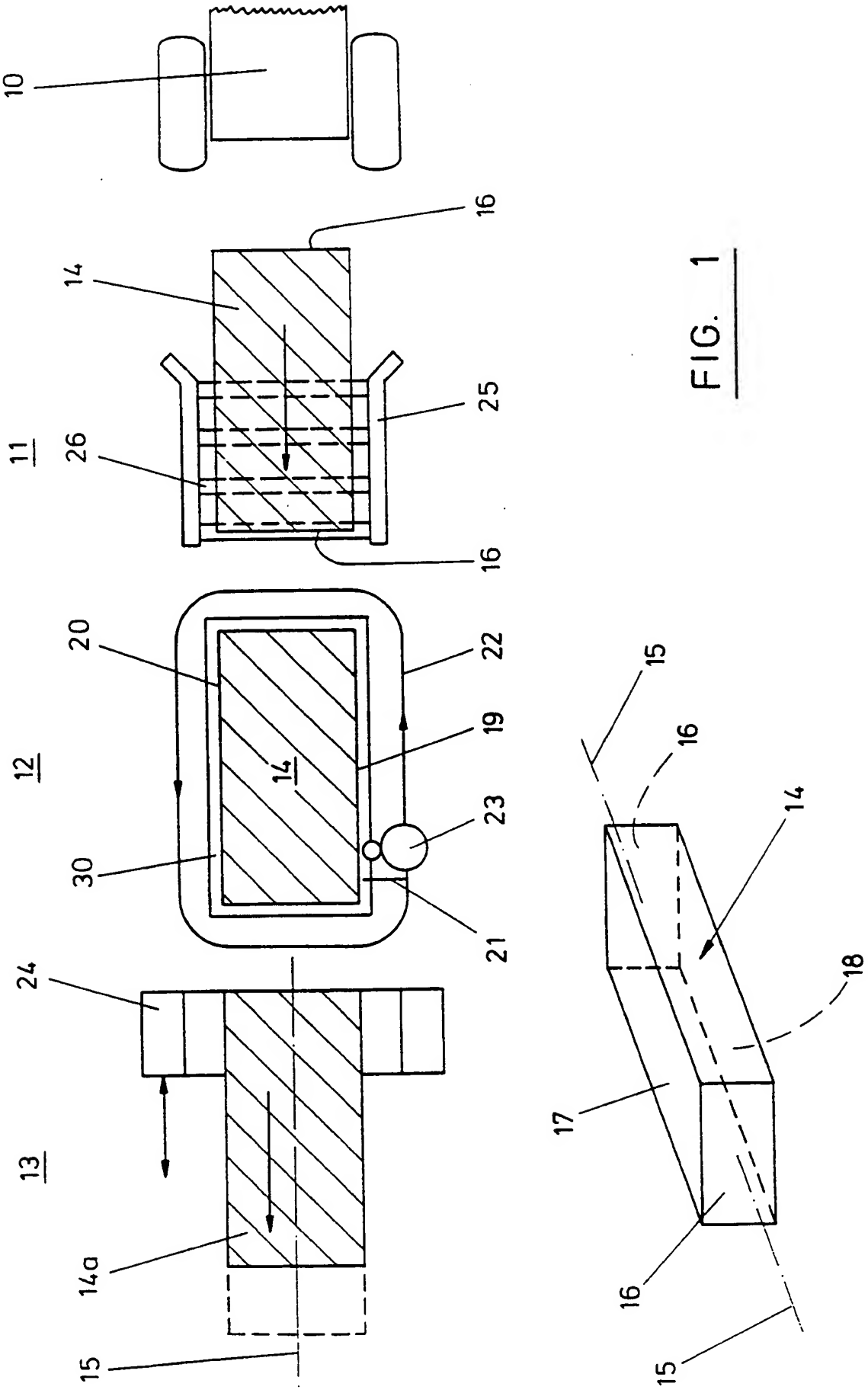
23. Apparatus according to Claim 22, in which each cradle can adjust itself so that the rollers (119) form a horizontal support platform for the bale (112) (Figure 9).

24. Apparatus according to Claim 23, in which the rollers (119) are operative to rotate the partly wrapped bale (112) through 90° so that a second stage of bale wrapping can take place.

25. Apparatus according to any one of Claims 21 to 24, including a rotatable film reel support (115A) arranged

downstream of the rollers (119) (Figure 10), and operative to apply helical overlapping windings of film around the partly wrapped bale (112A) upon movement (Y) of the partly wrapped bale through the rotatable film reel support (115A).

26. Apparatus according to Claim 25, including horizontal support rollers (126) arranged downstream of the rotatable film reel support (115A) to guide the movement of the bale (112A) as it receives the final helically overlapping windings of film prior to discharge from the apparatus.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16
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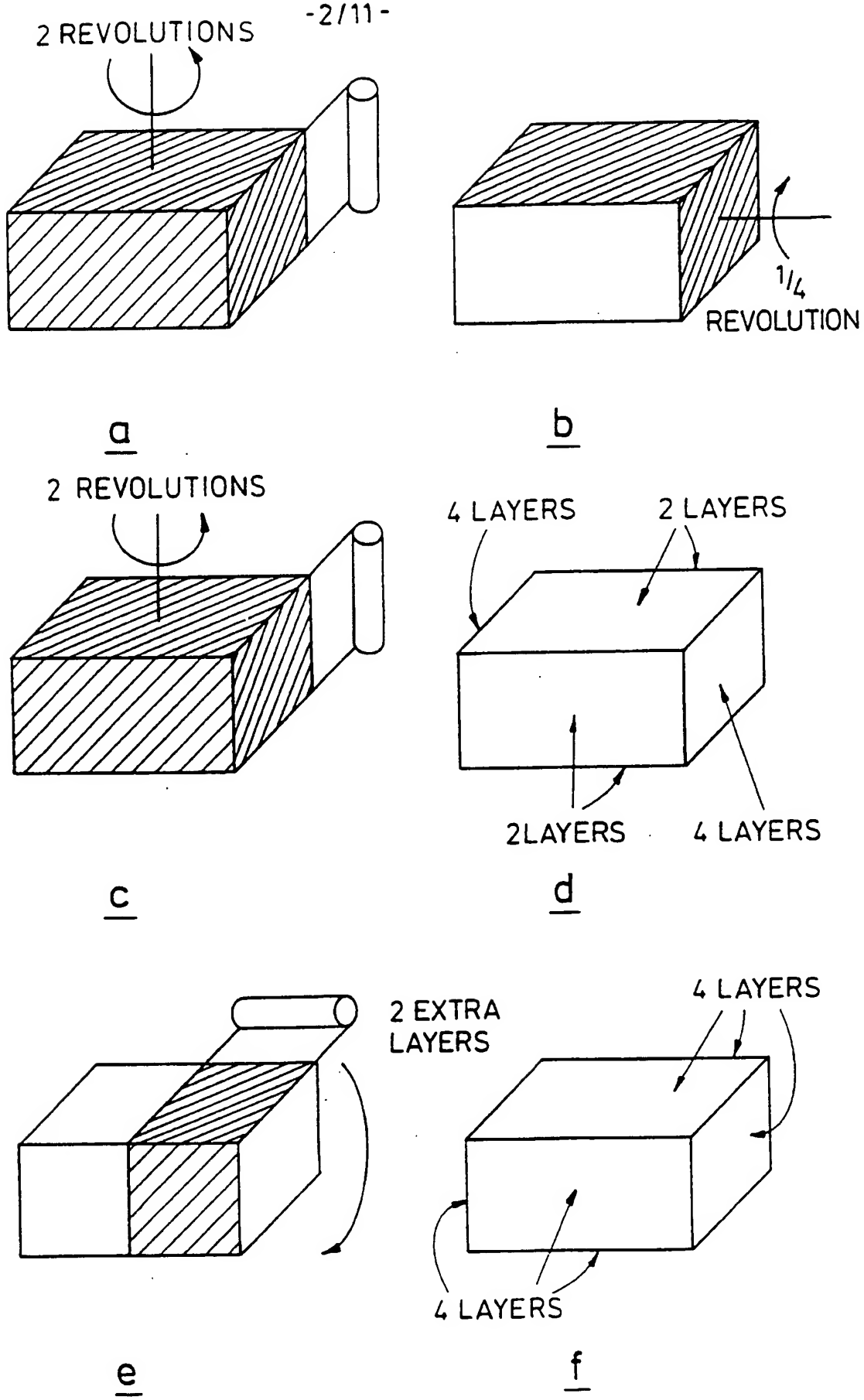
11
26
16
20
22
12
14
19
23
30
21
24
13
14a
15
15
16
14
18
17
16
15

FIG. 1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1/4
REVOLUTION
a
b
2 REVOLUTIONS
4 LAYERS
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2LAYERS
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c
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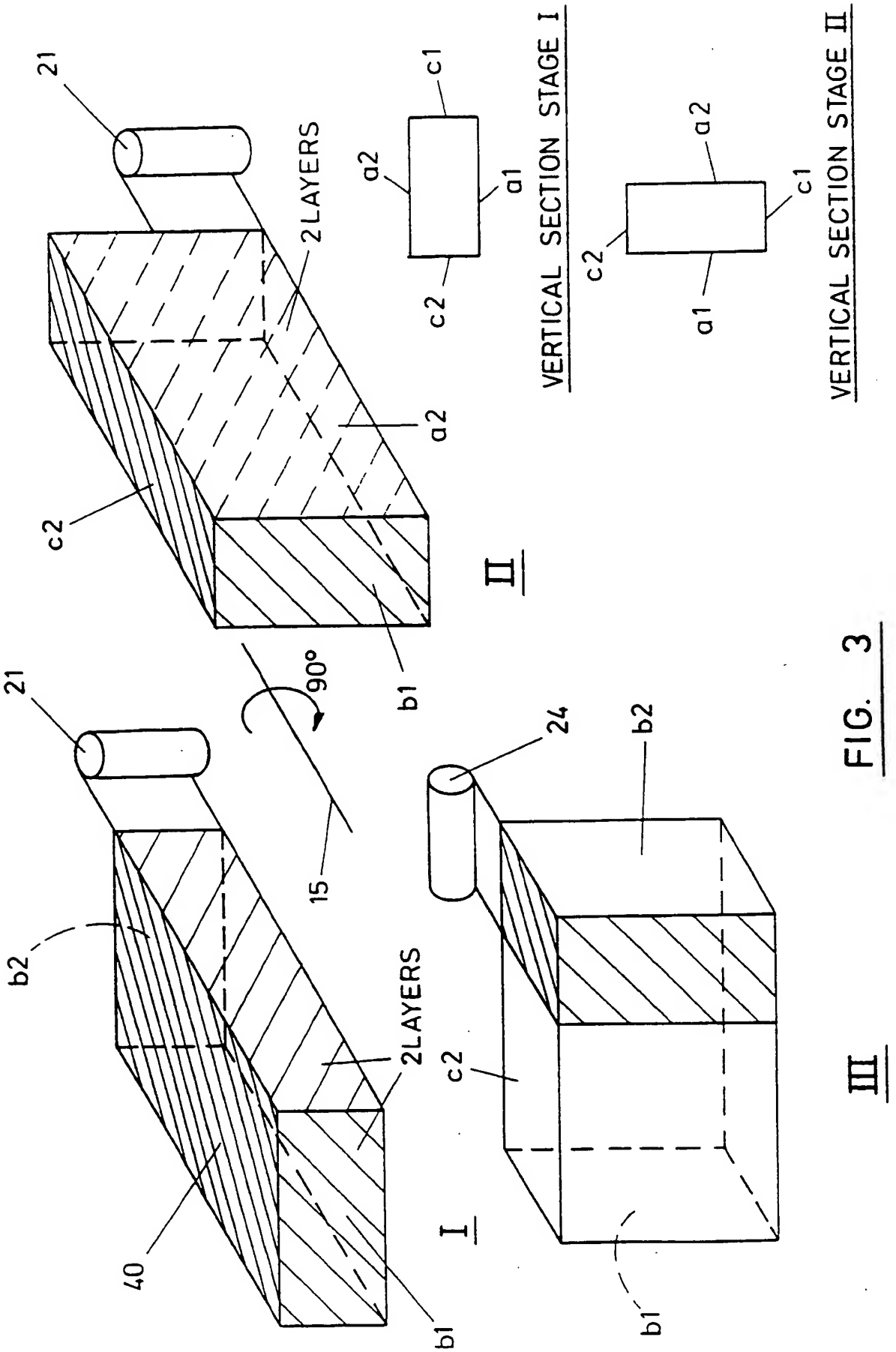
2 EXTRA
LAYERS
4 LAYERS
4 LAYERS
e
f

FIG. 2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c2
a2
b1
90°
15
21
b2
2LAYERS
40
b1
I
II
III
24
b2
c2
b1
VERTICAL SECTION STAGE I
c1
a2
a1
c2
VERTICAL SECTION STAGE II
a2
c1
c2
a1

FIG. 3

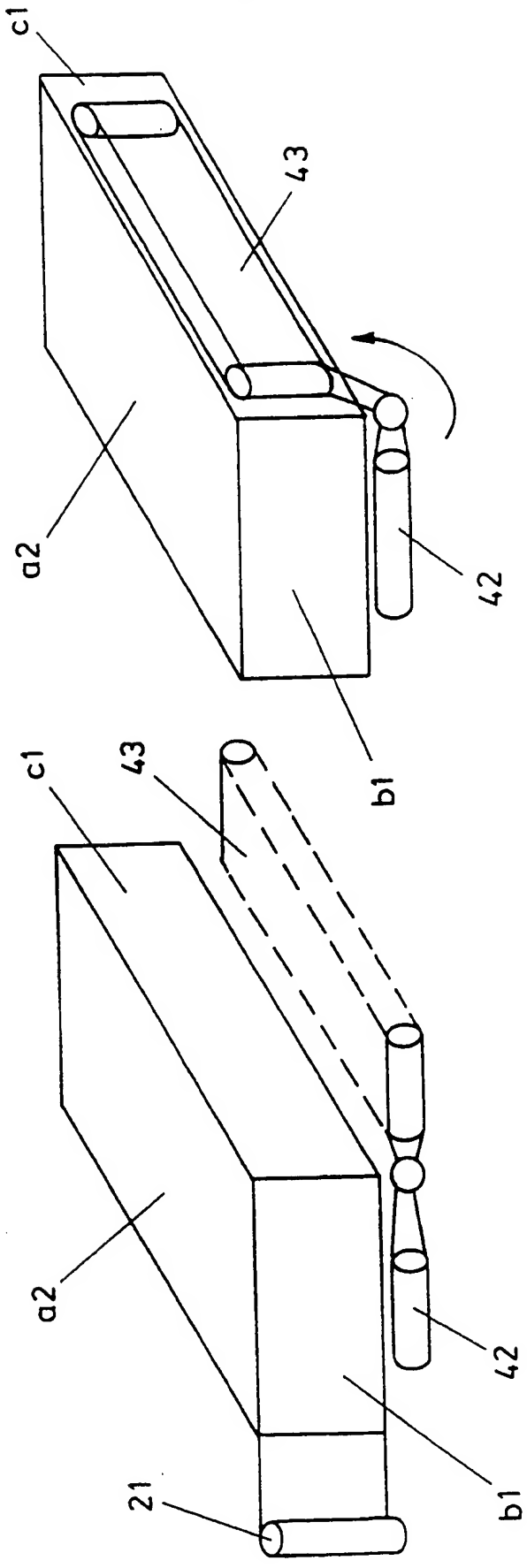


FIG. 4a

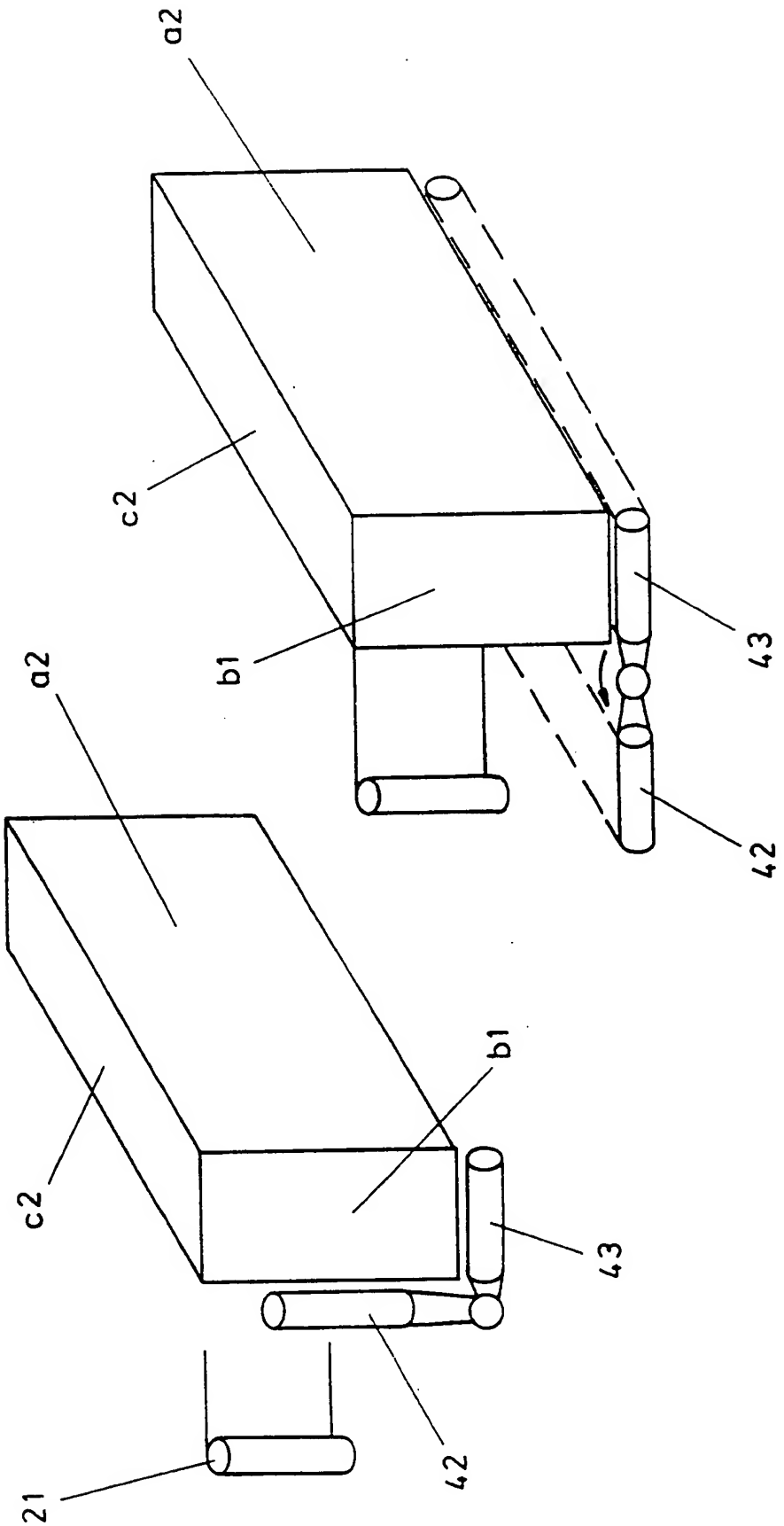


FIG. 4b

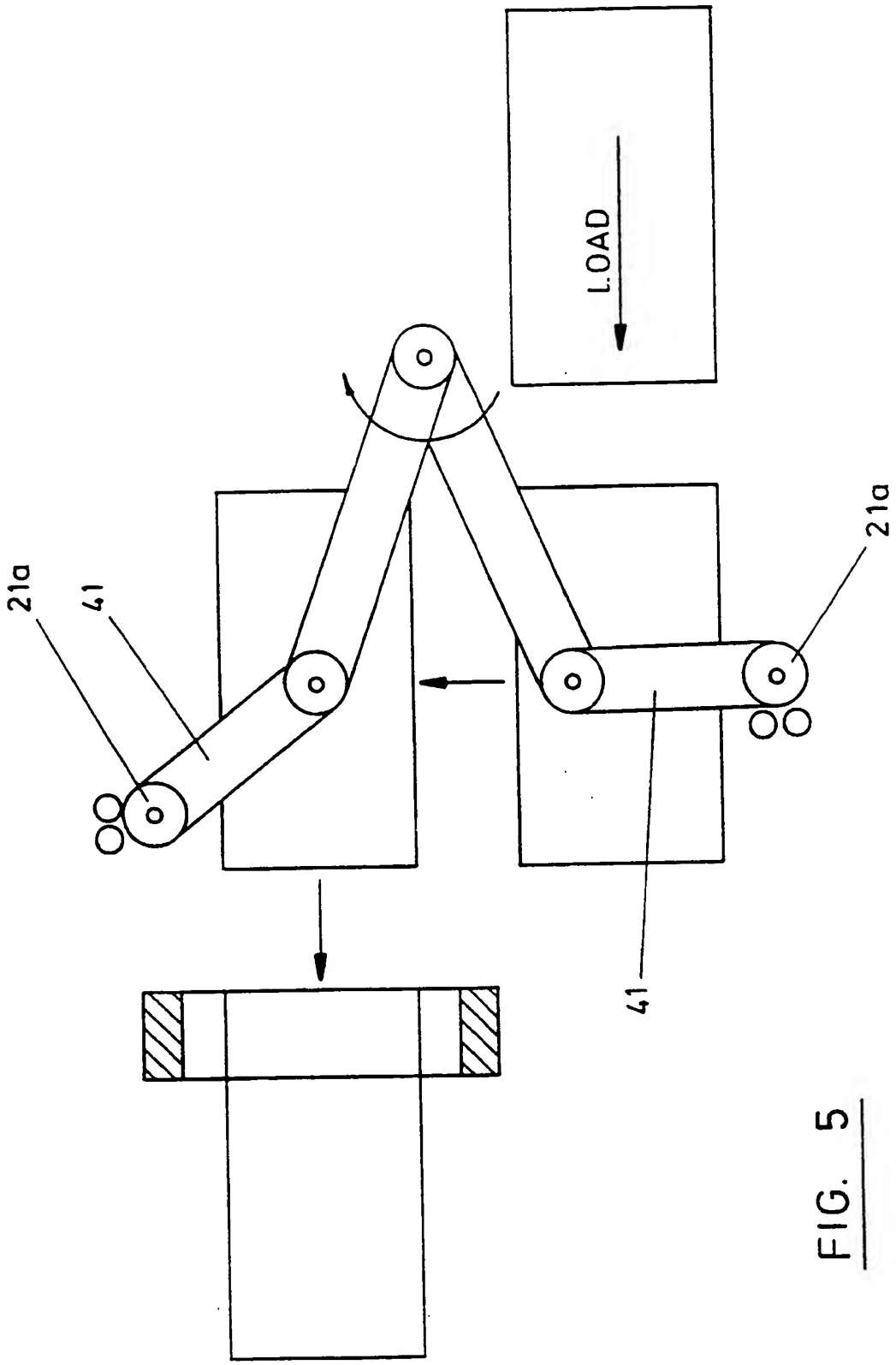
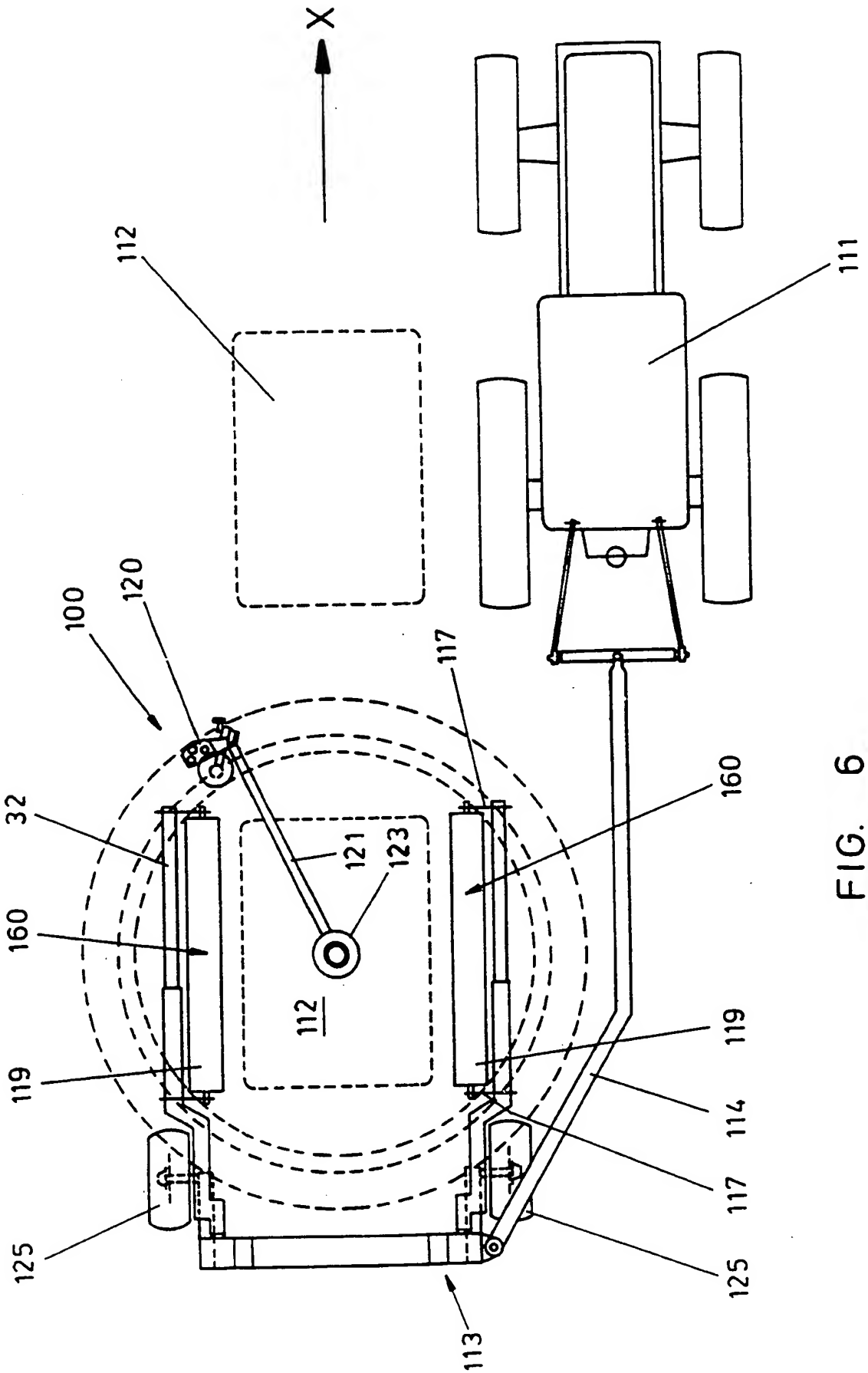


FIG. 5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112
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160
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113

FIG. 6

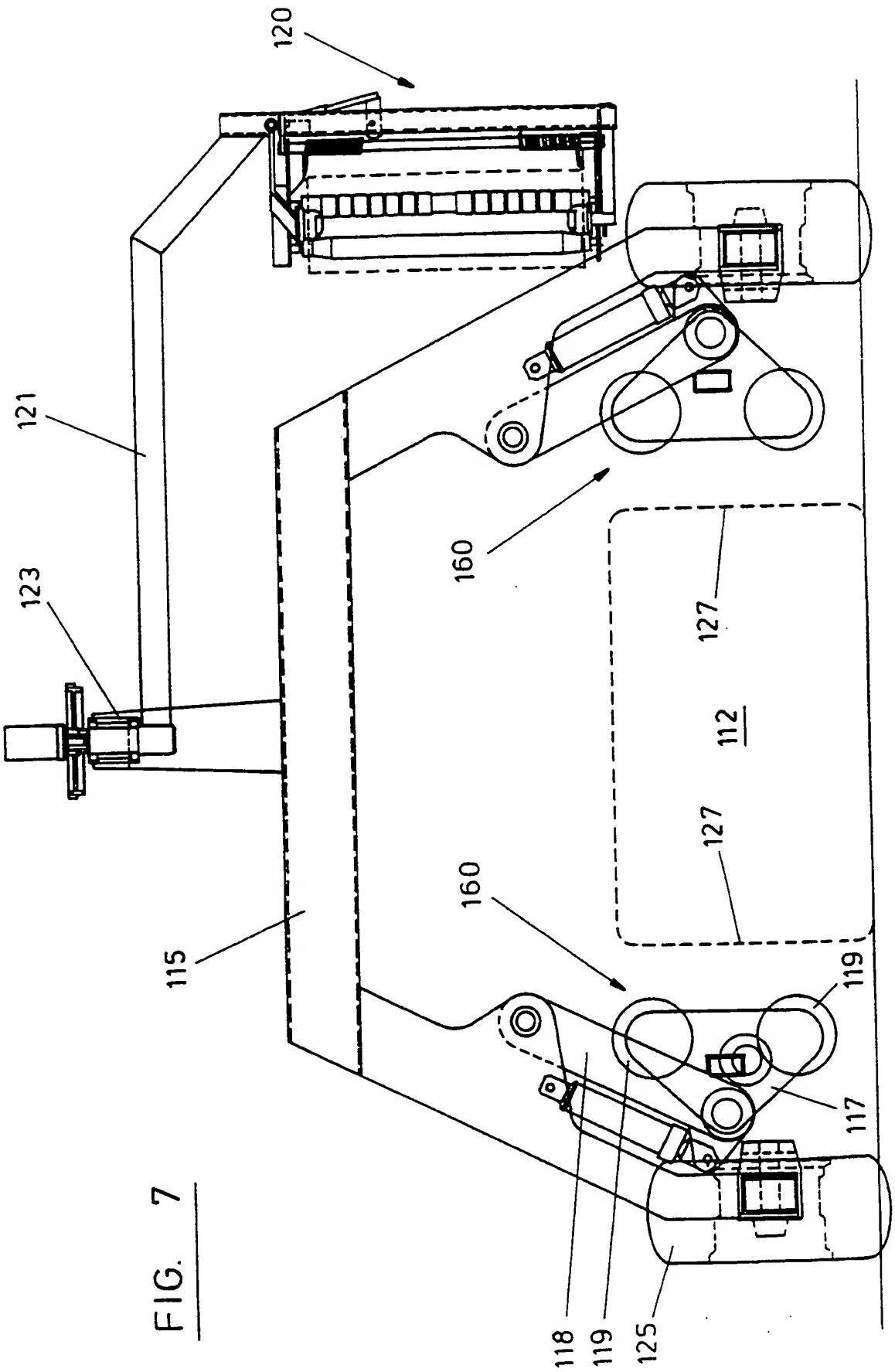

FIG. 7

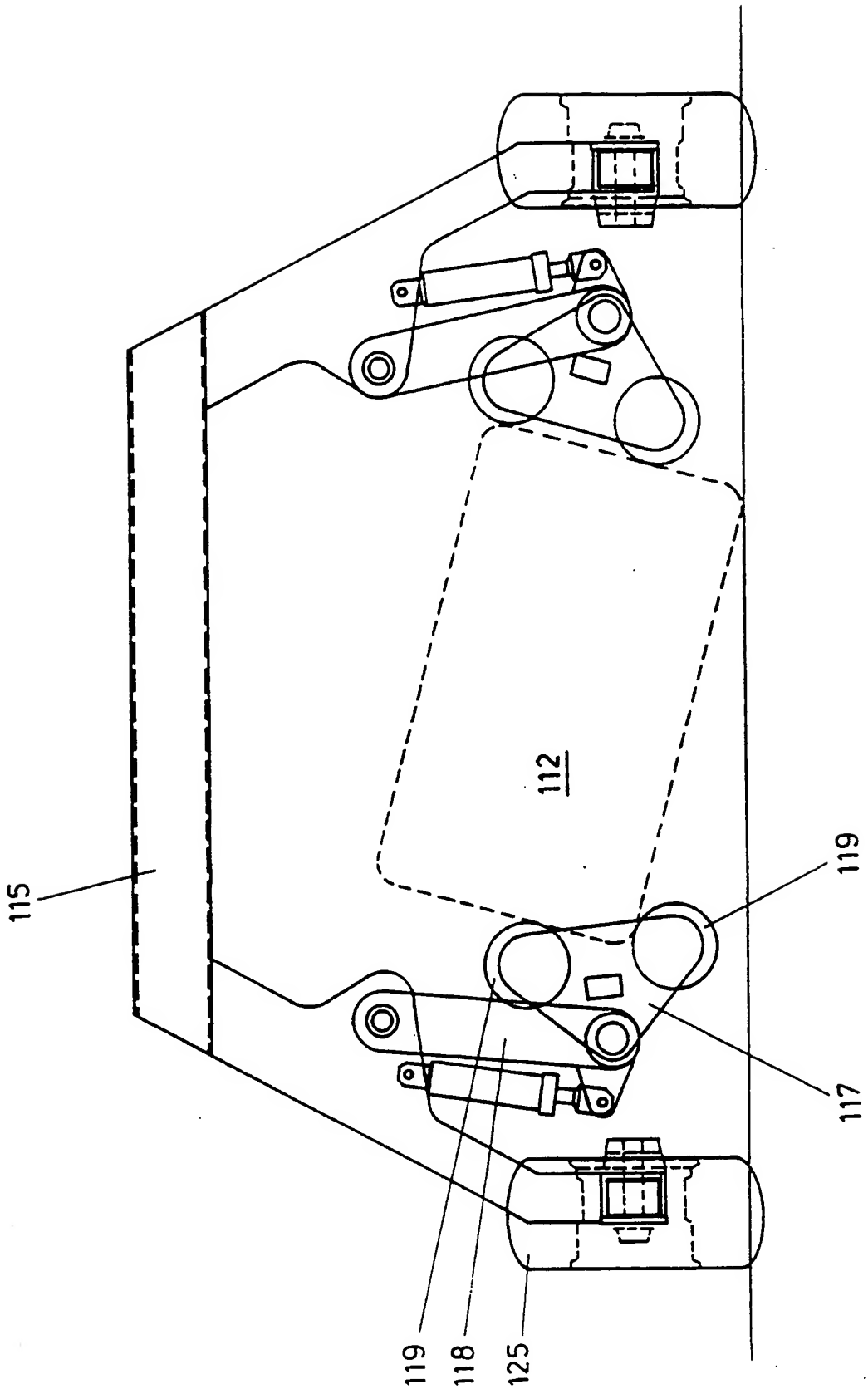

FIG. 8

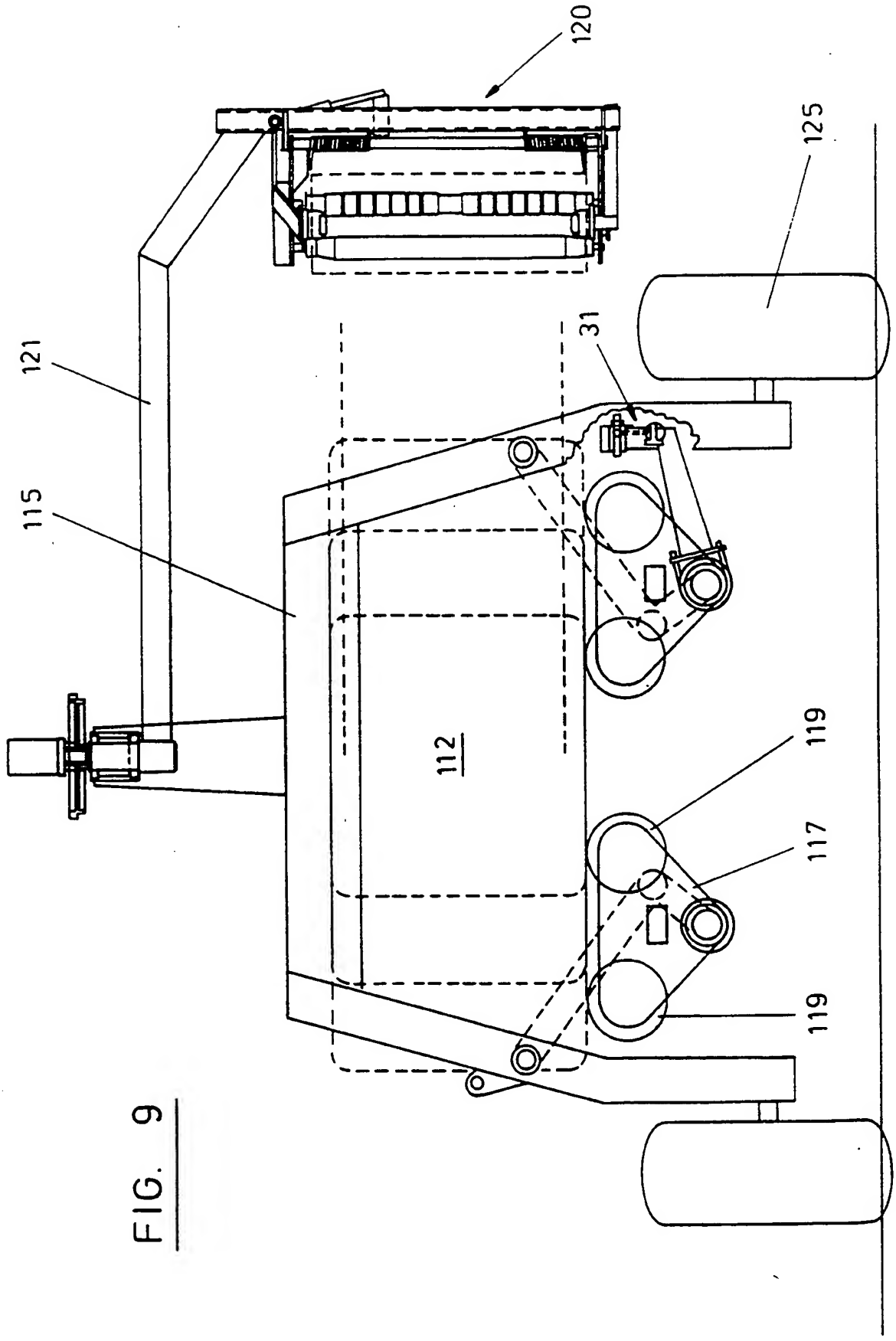

FIG. 9

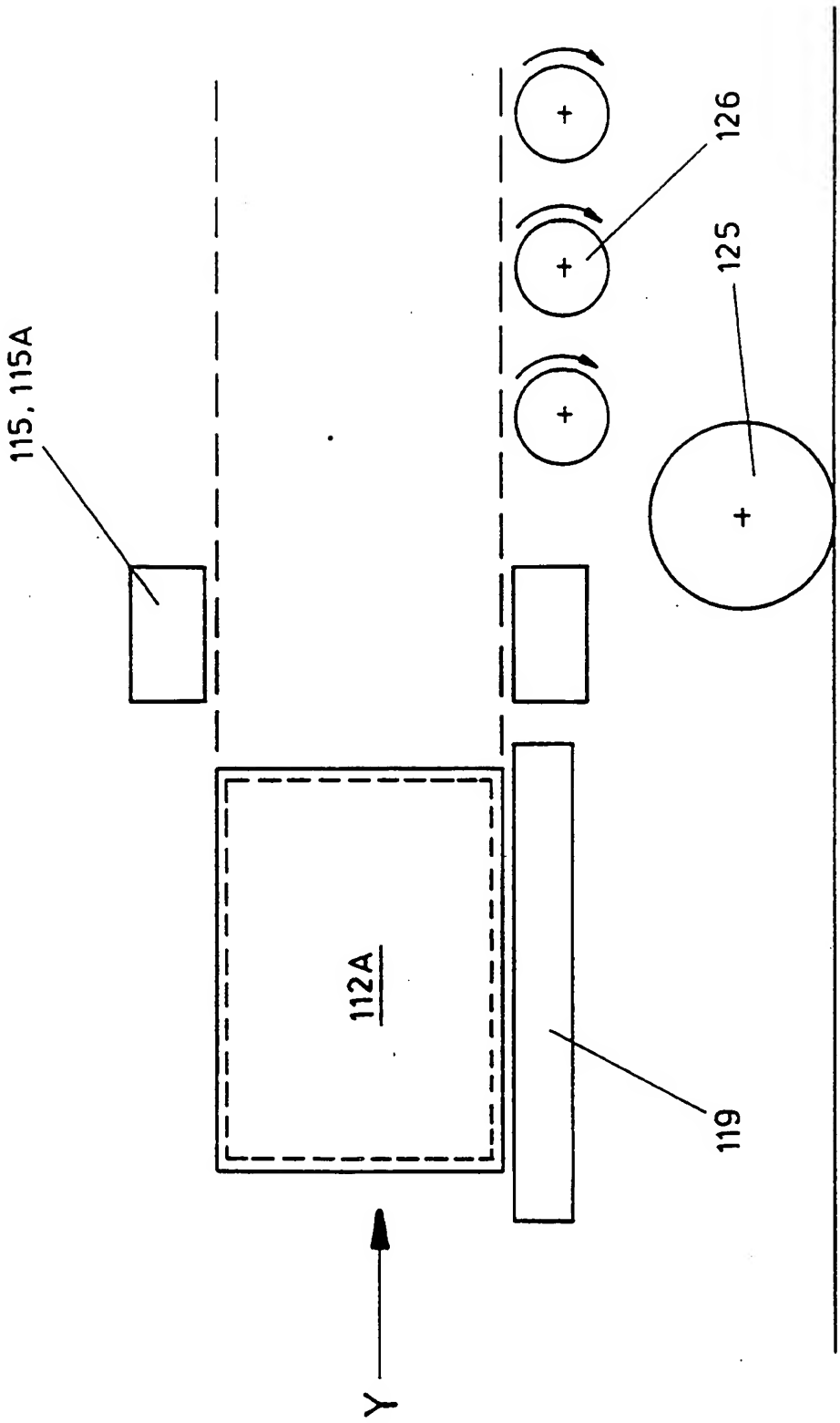

FIG. 10

INTERNATIONAL SEARCH REPORT

Int ional Application No
PCT/GB 93/01603

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 A01F15/07 B65B11/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 5 A01F B65B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE,A,40 37 533 (SCHENKE) 27 May 1992 see column 1, line 28 - column 2, line 63; figures 1-4	1,2,9, 11,15,17
E	EP,A,0 553 681 (BESTMANN) 4 August 1993 see column 4, line 48 - column 7; figures 1-3	1,2, 8-11,13, 15
P,A	EP,A,0 543 792 (SKOLE) 26 May 1993 see page 3, line 15 - line 58; figures 1-6	21-24
A	DE,A,40 16 424 (SCHENKE) 28 November 1991	

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 November 1993	15. 12. 93

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Vermander, R

Form PCT/ISA/210 (second sheet) (July 1992)

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-A-4037533	27-05-92	NONE	
EP-A-0553681	04-08-93	DE-A- 4201856	11-06-92
EP-A-0543792	26-05-93	CA-A- 2083104	23-05-93
DE-A-4016424	28-11-91	NONE	